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New Technology Proposal: Waste-to-Energy with CO2 Recycling

One significant opportunity for reducing greenhouse gas emissions is to stop emitting carbon dioxide (CO₂) greenhouse gas from Minnesota's waste-to-energy (WTE) facilities (or "district energy" facilities), such as the Hennepin Energy Recovery Center (HERC), the Newport Recycling & Energy Center (R&E), and the incinerators at the St. Paul Metropolitan Waste Treatment Plant. Technologies now exist (e.g., Chart Industries' Cryogenic Carbon Capture, CCC) that enable capturing and purifying the CO₂ produced in the WTE process. Chart's website states that "CCC reduces carbon emissions by 95 to 99% with half the cost and energy of competing processes and also eliminates harmful SO_x, NO_x and mercury pollutants from flue gases." Chilling the flue gas to condense the CO₂ also causes several other pollutants to condense out of the gas stream.

The liquified captured CO₂ can then be transported in Chart Industries' cryogenic trailers to a central processing facility, if necessary. The carbon atoms in the CO₂ can then be recycled by combining the CO₂ with "green hydrogen" (produced from water electrolysis in electrolyzers powered by renewable energy) to generate needed hydrocarbons. These hydrocarbons can include ethanol (e.g., from LanzaTech's bioreactors), which in turn can be converted to sustainable aviation fuel (SAF) for use at the Minneapolis-St. Paul (MSP) airport, using the LanzaJet technology. A CO₂-to-SAF facility could be built at or near the Flint Hills Resources Pine Bend Refinery in Rosemount, which already has a 1988 aviation fuel pipeline to the MSP airport.

Additionally, or alternatively, a CO₂-to-SAF facility could be built at the St. Paul Park Marathon Refinery near the Newport Recycling & Energy Center, just across the river from the St. Paul Downtown Airport. CO₂ captured from the incinerators at the St. Paul Metropolitan Waste Treatment Plant could be taken to either CO₂-to-SAF facility.

Similarly, technology from MAN Energy Solutions can recycle captured CO₂ to methanol and on to (renewable) gasoline. Using these "e-fuels" made from "recycled CO₂" displaces conventional fossil fuels, leaving more fossil fuel underground by recycling the carbon that is already above ground. This principle is summarized in the diagram below, from the Renewable Carbon Initiative website at <https://renewable-carbon-initiative.com/>.

The electricity (and heat) generated by a waste-to-energy (WTE) facility can provide part of the energy needed to produce the "green hydrogen" for the CO₂ recycling process. Converting a traditional WTE facility to a "CO₂ recycling" facility should arguably raise the facility to the "recycling" level in the plan's hierarchy.

For future systems, an alternative to typical waste-to-energy facilities is a partial oxidation or "gasification" system that produces "syngas", a key starting material for many chemical processes. LanzaTech has demonstrated using gasification of municipal solid waste (MSW) to produce ethanol in Japan. This ethanol could provide the starting material for other chemicals or e-fuels. The draft plan only mentions one version of gasification briefly, on page 40.

Environmental Justice Issues and the Hennepin Energy Recovery Center (HERC)

Several local organizations, such as the Minnesota Environmental Justice Table, have noted that the HERC facility is located near some communities that rate high on the Environmental Justice Index for suffering a cumulative impact of multiple environmental stressors, including high transportation vehicle emissions, industrial facilities, exposure to pollutants, and other environmental factors affecting health. Despite HERC operating within permitted emissions limits with the aid of its various pollution abatement measures, it is still one of the larger local emitters among permitted point sources in Hennepin County. As a result, some in the community are pushing to close the HERC facility to reduce its contribution to the cumulative impact. Alternatively, updating HERC's technology could further reduce HERC emissions to a more acceptable level. The pros and cons of such actions need to be explored.

The Hennepin County Zero Waste Plan Executive Summary says on page 3, "The county has defined zero waste as preventing 90% or more of all discarded materials from being landfilled or incinerated."

The "Zero-waste equity and access actions" section of this "10% waste plan" states on page 22 that, "Until the county can achieve zero waste, the need for an end-of-life destination for non-recovered items, whether it is an out-of-county landfill, incinerator, or some other option, remains. As the county approaches zero waste, the need for disposal will be reduced but will not disappear entirely. The following set of actions is aimed at reducing reliance on the HERC and increasing equity.

A.9 Evaluate HERC upgrades to reduce impacts on community in the short term

A.10 Establish milestones to phase out the use of the HERC as county approaches zero waste".

Both items above are indicated as low-hanging fruit, with item A.9 having an impact level of 4 and item A.10 having an impact level of 1. The proposed HERC CO₂ capture technology upgrades described above would further reduce emission impacts of pollutants on the community, in addition to reducing greenhouse gas emissions as desired under the Metropolitan Solid Waste Management Policy Plan 2022-2042.

Past inequalities such as red-lining and locating (previously) polluting facilities near red-lined areas could cause some to feel that areas like North Minneapolis are being treated as sacrifice zones. However, our actions should be based on the present facts and data regarding actual harm to the community, not past issues. The discussion below will show that HERC is only a minor contributor to the total "criteria pollutants" in the county. Closing HERC would have a negligible effect on the health of the surrounding communities, including those with high concentrations of low-income people or people of color.

Present and Potential Future Benefits of HERC (and Other Waste-to-Energy Plants)

From the viewpoint of the draft Metropolitan Solid Waste Management Policy Plan, the main purpose of waste-to-energy facilities like HERC is to slow the growth of wasteful landfills while extracting value from waste materials that cannot be reused, recycled, or composted, such as difficult-to-recycle "plastics" (e.g., Styrofoam), broken plastic toys, wastewater treatment sludge, etc. Burning or gasifying waste releases energy that can be used for heating and/or producing electricity, while also reducing the volume of the remaining solid waste to only noncombustible ash. In the case of "district energy" facilities like HERC, the unit provides heat to nearby buildings and generates electricity that can be sold to the electrical grid, in addition to powering the facility itself. The combustion process also produces some gases and airborne particles that may be pollutants that must be captured and preferably recycled, such as sulfur dioxide. However, Minnesota is currently missing an opportunity to capture and recycle a major product of the process,

the greenhouse gas CO₂. As explained above, technologies exist that would allow HERC and other waste-to-energy plants to capture CO₂ (or CO), combine it with "green hydrogen" produced with low-carbon renewable energy, and convert the "carbon" into chemicals and e-fuels like "green" ethanol, methanol, gasoline, and sustainable aviation fuel. This provides long-term storage of renewable energy, including "excess" renewable energy produced when more wind and solar is available than can be immediately used on the electrical grid. Such "excess renewable energy" is currently "curtailed" and wasted. Storing renewable energy in "recycled CO₂ hydrocarbons" also minimizes the need to pull new fossil fuels out of the ground, by recycling the carbon that is already above ground. If the CO₂ is captured using technology like Chart Industries' Cryogenic Carbon Capture, this could also further reduce the emissions of pollutants like SO_x, NO_x, and mercury from HERC, as described above.

HERC's Contribution to Air Emissions and Pollutants in Hennepin County

According to the Minnesota Pollution Control Agency (MPCA), "Typically, when people think of sources of air pollution, they think about buildings with big smokestacks like power plants and factories. Only about a quarter of the air pollution in Minnesota comes from smokestack facilities. The rest comes from a wide variety of everyday, neighborhood sources", including vehicles (transportation.)

The sources of emissions in Hennepin County (and elsewhere) can be divided into three categories:

1. Point sources,
2. Area sources, like residential heating, backyard barbecues, non-permitted businesses like gas stations, dry cleaners, and body shops, etc., and
3. Mobile sources.

The HERC facility is classified as one of the permitted point sources in Hennepin County. The Minnesota Pollution Control Agency (MPCA) Statewide Air Emissions Data for 2020 shows that the total NO_x emissions in Hennepin County were about 36 million pounds (18,000 tons), while Point Source Air Emissions Data shows the NO_x emissions from HERC were 383 tons, or about 2% of the county NO_x emissions. "Onroad" mobile sources (cars, buses, trucks) produced 33.09% of the county's total 2020 NO_x emissions, while "nonroad" mobile sources (airport, trains, commercial marine vessels, etc.) produced 29.97%. Similarly, the total Hennepin County 2020 PM_{2.5} primary emissions were about 15 million pounds (7500 tons), while the HERC emissions were 16 tons, or about 0.2%. The onroad mobile sources produced 23.28% of the total county PM_{2.5} emissions, while the nonroad mobile sources produced 5.56% of the PM_{2.5}. The results are similar for other "criteria pollutants".

According to the Environmental Defense Fund,

"While the delivery trucks and tractor trailers that distribute goods and cargo make up only about 4% of vehicles on U.S. roads, they are responsible for nearly half of the nitrogen oxide emissions and nearly 60 percent of the fine particulates from all vehicles, and about 7% of all greenhouse gas emissions in the U.S."

This suggests that a greater impact would be made on Hennepin County air quality by transitioning from diesel trucks to zero emission trucks powered by batteries or hydrogen fuel cells. The county or state could address this issue by requiring all garbage trucks serving HERC to transition to zero emission trucks and providing funding for the transition. HERC could provide these trucks with an on-site "green" hydrogen charging station (with hydrogen from either electrolysis or gasification of garbage).

Consequences of Closing the HERC Facility

Despite the aspirational goal of building a zero-waste society, I believe there will always be solid

waste materials such as wastewater treatment sludge, dirty or difficult-to-recycle plastics, etc., that are best sent to a waste-to-energy facility (that employs carbon capture and recycling), to reduce the volume of waste that must be sent to nonproductive landfills. This follows the plan's hierarchy shown above in Figure 4. Minnesota's solid waste management hierarchy of preferred methods. Having waste-to-energy facilities like HERC centrally located in a high population area reduces the state's transportation pollution and greenhouse gas emissions by minimizing the total distance garbage trucks need to travel to the central processing site. If HERC were closed, it would need to be replaced by an equal (or larger) plant, possibly outside Hennepin County. This would increase the total emissions from garbage trucks travelling from the pickup points to the processing site. Since there is probably not enough capacity at the Newport Recycling & Energy Center, Red Wing, or Mankato to pick up the load from HERC, a new facility would need to be built. This could require taking someone's land through prolonged eminent domain proceedings, and it could potentially be located near another disadvantaged community, creating another environmental justice issue. This is in addition to the cost and time involved in building the new plant. And of course, the county would need to replace the heating that HERC supplied to nearby buildings as a district energy source.

Proposal to Fund an Engineering and Design Study

I have been working with some local nonprofit organizations and my state representative, Amanda Hemmingsen-Jaeger, to propose legislation that would fund a front-end engineering and design (FEED) study to evaluate a project that would add CO₂ capture and recycling to HERC (or another waste-to-energy facility). The captured CO₂ would then be combined with green hydrogen and converted to valuable hydrocarbons such as sustainable aviation fuel, which may also be eligible for a state tax credit. This could significantly reduce the air pollution and greenhouse gas emissions of the facility, the airport, and the state. Once the system has been demonstrated here, it could be replicated at WTE facilities and incinerators across the state and elsewhere.

Urgent Need to Quickly Reduce Minnesota's CO₂ Greenhouse Gas Emissions

Considering the current record global heat wave, air quality alerts from Canadian wildfires, prolonged drought in the Southwest, record flooding in Vermont, etc., Minnesota needs to quickly demonstrate its commitment to significantly reducing the state's CO₂ greenhouse gas emissions!